Ministry of Higher Education and Scientific Research
Dept. of Production Engineering and Metallurgical
Branch: Mining and Extractive metallurgy

Lab Report

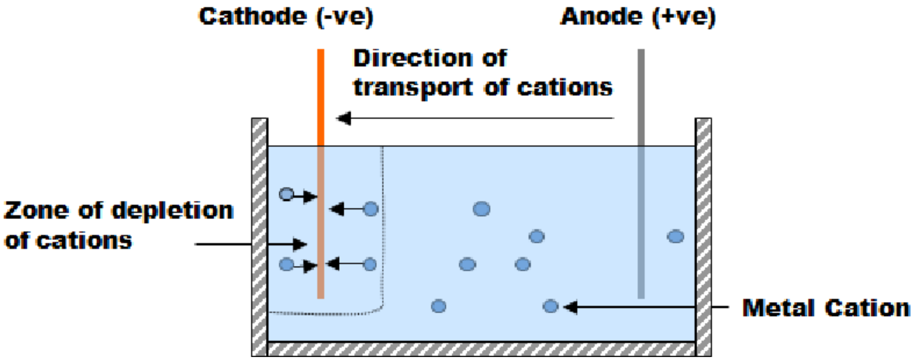
Electro winning

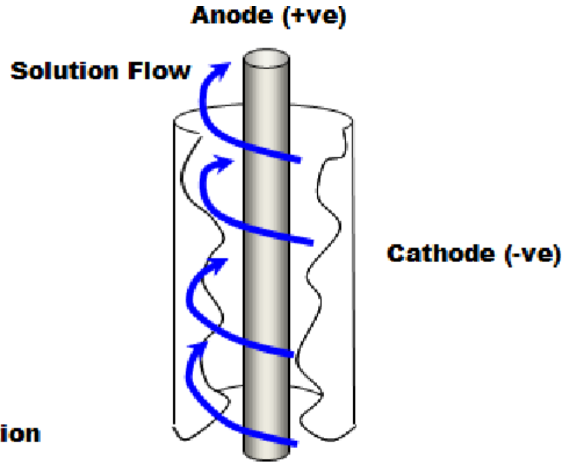
What is Electro winning Extraction?

Electro winning (or electroextraction) is a process of whereby metals, such as gold, silver and copper, are recovered from a solution by means of electrolytic chemical reaction. This takes place when an electric current is passed through the solution. During the process, electrons from the electric current chemically reduce the metal ions, to form a solid metal compound on the cathode (the negatively charged electrode). The metal is deposited in a form that can be readily smelted easily into a more usable form. The metals will frequently have been put into the solution, from the ores, using a leaching process.

The principles of Electro winning:

An electrolytic process is based on the principles of electrolysis. Electrically conductive solution is created when an electrolyte is dissolved in water or other polar solvents. Electrolytes consist of positively and negatively charged ions (cations and anions). When a DC voltage is applied to the solution the positively charged ions (cations) move toward the cathode, while negatively charged ions (anions) move toward the anode. Processes like this are called electrolytic and electro winning is based on this principle. A conventional electro winning unit consists of a tank, rectifier, and pump. Cathodes and anodes are aligned inside the tank. The pump fills the tank with an electrolytic solution. Electrical current is provided by electro winning rectifier to cathodes and anodes in such a way that the difference in electrical potential creates a movement of cations towards the cathode. As time goes by the positively charged ions will plate on the cathodes. It is important to note that as metal builds up on the cathode the deposition of metal in the solution will decrease and the plating will slow down. Once the metal deposition decreases to a rate that is not sufficient for electroplating, the cathodes with pure metal deposited will be harvested. In the case of wastewater treatment, the solution (wastewater) will be cleaned or significantly purified of non-ferrous metals and can be further treated by chemical precipitation or reused within the industrial process.


Cathode (-ve)
Anode (+ve)
Direction of transport of cations
Zone of depletion of cations
Metal Cation



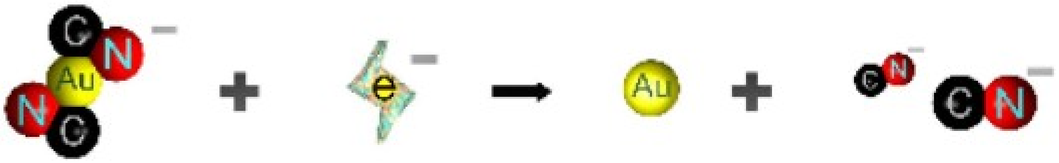
Electro winning of Gold:

Process of electrowinning of gold, also called electric extraction, is a process of recovering gold by desorption electrolysis of gold loaded carbon under high temperature and high pressure conditions. It is an important part in the gold cyanidation process.

The high temperature and high pressure gold loaded carbon process of electrowinning of gold is the most common technology used in gold loaded carbon desorption electrolysis equipment technology. In this process, first of all, the grade of gold loaded carbon is very high. At the same time, the length of desorption time is controlled according to the grade of gold loaded carbon. Only when the gold loaded carbon grade and desorption time reach the optimal configuration, the purification of gold is the most standard. Due to the increasing accumulation of gold cyanidation experience, the new process of electrowinning of gold is becoming more and more widely used.

Cathode Reaction - Gold Deposition

Gold is electrolytically displaced from the alkaline cyanide solution (pregnant eluate) and deposited on the cathode surface according to the reaction:



$$Au(CN)_2^- + e^- \longrightarrow Au + 2CN^-$$

Gold Cyanide Ion + Electron ⟶ Solid Gold + Cyanide Ion

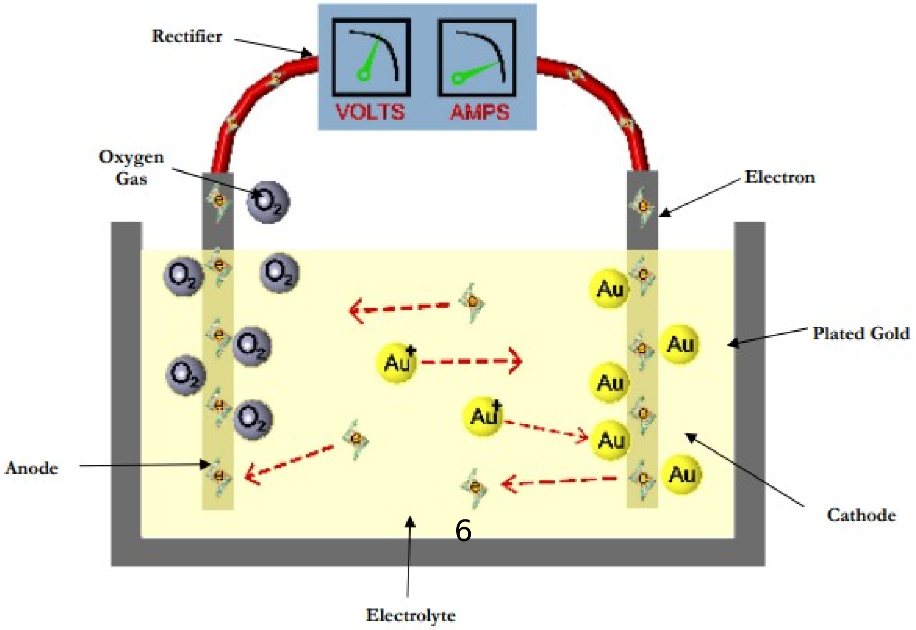
The rectifier acts, as a battery supplying the electrons (electricity) required for the reaction to proceed. An electron is the basic unit of electricity, The gold cyanide complex is 'split' into a solid gold particle attached to the cathode and cyanide ions that remain in solution. The cathodes are constructed from mild steel wool woven around a stainless steel frame for support The cathodes are contained in plastic boxes which also provides support for the steel wool and prevents the cathodes from touching the anodes which would short circuit the system. The steel wool has a high surface area, which means a large number of sites for the deposition reaction to take place. This leads to higher efficiency and reduces the time required for electrowinning. Once the cathodes are laden with the required amount of gold they are removed from the cells for calcining followed by smelting to produce gold bullion.

Cell Anodes

The anodes, or positive electrodes, are made of stainless steel mesh. The anode does not collect gold but is necessary for the current to flow, completing the electrical circuit within the cell. It is important that the eluate has a high pH, as the anodes will corrode at pH less than12.5. Oxygen gas produced by the oxidation of water is the main reaction occurring at the anode.

$$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$$

Water ⟶ Oxygen + Hydroxyl Ions + Electrons



The process of electrowinning of gold is usually divided into the following steps:

Solvent Desorption

The desorption liquid and the gold loaded carbon in the process of electrowinning of gold are respectively placed in different mass transfer layers in the comprehensive desorption tower, that is, the pregnant liquid is concentrated in the lower part of the comprehensive desorption tower, and the gold loaded carbon is placed in the middle and lower layers of the comprehensive desorption tower and only let the non-gold-loaded pulp and water vapor enter the middle of the comprehensive desorption tower from the top to the bottom to carry out vapor-solid, liquid-solid full contact and reaction with the gold loaded carbon to desorb the gold in the gold loaded carbon, so as to achieve steam desorption.

Solvent Condensation

The desorption liquid and the gold loaded carbon in the process of electrowinning of gold are respectively placed in different mass transfer layers in the comprehensive desorption tower, that is, the pregnant liquid is concentrated in the lower part of the comprehensive desorption tower, and the gold loaded carbon is placed in the middle and lower layers of the comprehensive desorption tower and only let the non-gold-loaded pulp and water vapor enter the middle of the comprehensive desorption tower from the top to the bottom to carry out vapor-solid, liquid-solid full contact and reaction with the gold loaded carbon to desorb the gold in the gold loaded carbon, so as to achieve steam desorption.

Pregnant Electrolysis

The pregnant liquid obtained after solvent vapor desorption in the middle section of the integrated desorption tower first flows into the pregnant liquid section in the lower part of the integrated desorption tower for storage. After the concentration of pregnant liquid is increased to the process index in the process of electrowinning of gold, it is transported to the electrolytic cell by the pregnant liquid pump, and the pregnant liquid is electrolyzed to obtain coarse gold by controlling the direct current of the electrolytic cell. It is also an important step in the process of electrowinning of gold.

Get Gold Ingots

This is the last step of the process of electrowinning of gold. After the obtained gold slime is simply pickled to remove impurities, the gold ingot can be directly smelted.

What’s more, the new process of electrowinning of gold has the following advantages:

(1) High recovery rate

(2) Automatical process

(3) Safe operation process

The process of electrowinning of gold has the following five advantages: faster electrolysis, lower tailings grade, safe and reliable operation process, high degree of system automation, and good economic benefits. Therefore, it is widely used in gold processing plants.

Electrowinning extraction has several advantages and disadvantages:

Advantages:

1. High efficiency: Electrowinning is known for its high metal recovery rates, making it an efficient extraction method.

2. Selective extraction: It allows for the selective extraction of specific metals, which is beneficial when targeting specific elements.

3. Low operating costs: Electrowinning can be cost-effective due to its low energy consumption and minimal chemical requirements.

4. Environmental friendliness: Compared to other extraction methods, electrowinning produces less waste and has a lower environmental impact.

Disadvantages:

1. Limited applicability: Electrowinning is primarily suitable for extracting metals from aqueous solutions, limiting its use in certain extraction scenarios.

2. High capital costs: The initial setup cost for electrowinning can be significant, requiring specialized equipment and infrastructure.

3. Potential impurities: Depending on the source material, electrowinning may result in impurities being co-extracted along with the desired metal.

4. Energy-intensive: While electrowinning is energy-efficient compared to some other extraction methods, it still requires a significant amount of electricity.

It's important to note that the advantages and disadvantages may vary depending on the specific application and context in which electrowinning is being used.

References

https://quoteddata.com/glossary/electrowinning-or-electroextraction/

https://blog.emew.com/electrowinning-101-what-is-electrowinning

https://www.cnlitereagent.com/news/process-of-electrowinning-of-gold/

https://www.google.com/url?sa=i&url=https%3A%2F%2Frsteyn.files.wordpress.com%2F2010%2F07%2Felectrowinning-and-smelting-basics.pdf&psig=AOvVaw3W5ATAlrnBjPNSlnKq5PTP&ust=1701731061812000&source=images&cd=vfe&opi=89978449&ved=0CBQQjhxqFwoTCPiKvK2w9IIDFQAAAAAdAAAAABAI